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(54) Spindle motor stop control device.

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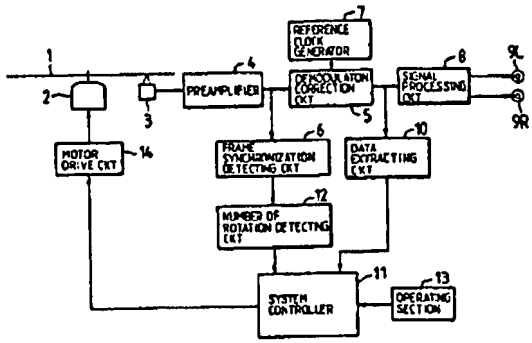
FIG. 1



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SPINDLE MOTOR STOP CONTROL DEVICE

This invention relates to spindle motor stop control devices, and more particularly to a device for stopping a spindle motor which rotates at high speed.

In a conventional spindle motor stop control device, a frequency generator (FG) operating in association with the spindle motor is used to detect the motor speed. That is, the speed of the spindle motor is detected from the output of the frequency generator, so that, according to the speed of the spindle motor, a reverse torque braking force is applied to the spindle motor thereby to stop the latter. However, the conventional device is disadvantageous in that the frequency generator is expensive, and the use of the expensive frequency generator for only the stop control of the spindle motor is not economical.

To overcome this difficulty the following method has been employed: After a reverse torque braking force is applied to the spindle motor, the speed of the latter is monitored, and the application of the reverse torque braking force is allowed to last for a predetermined period of time t from the time instant that the speed of the spindle motor is decreased to a

One preferred embodiment of this invention will be described with reference to the accompanying drawings.

Fig. 1 is a block diagram outlining the arrangement of a disc player with a spindle motor stop control device according to the invention. In Fig. 1, a disc 1 is rotated by a spindle motor 2, and its recorded data are read with an optical pickup 3. The optical pickup 3 comprises: a light source, namely a laser diode; an optical system including an objective lens; a photo detector for receiving a light beam reflected from the disc 1; a focus actuator for controlling the position of the optical axis of the objective lens with respect to the data recording surface of the disc 1; and a tracking actuator for controlling the position of the spot of the light beam in a radial direction of the disc which is applied to the recording track by the pickup 3 with respect to the recording track.

The read output of the pickup 3 is applied through a preamplifier 4 to a demodulation/correction circuit 5 and a frame synchronization detecting circuit 6. The circuit 5 subjects the read output; i.e., an EFM (eight to fourteen-modulation) signal to EFM demodulation and writes it in a memory (not shown) such as a RAM, and, with the aid of a reference clock pulse signal from a reference clock generator 7, controls the memory, to perform the deinterleaving of data and an error correction by using the parity bits in the data. The digital audio signal demodulated and corrected by the circuit 5 is supplied to a data extracting circuit 10 and to a signal processing circuit 8 comprising a D/A (digital-to-audio) converter and a deglitcher where it is processed. The output of the signal processing circuit 8 is applied to a right channel audio output terminal 9R and a left channel audio output terminal 9L. The data extracting circuit 10 operates to extract subcode data, and the data thus extracted is applied to a system controller 11.

The frame synchronization detecting circuit 6 is to detect the read output frame synchronization signals recorded on the disc with a predetermined period. The pulse width of the frame synchronization signals is 22T (where T = 1/8.6436 MHz) when the disc is rotated at a predetermined number of rotations. The disc player further comprises a number of rotations (rpm) detecting circuit 12 which utilizes the pulse width to detect the speed of the spindle motor 2. The detecting circuit 12 outputs a detection signal when the speed of the spindle motor 2 is decreased, for instance, to about one-third of the predetermined value; that is, when the frame synchronization signal pulse width is increased from 22T to 64T (about three times as large as 22T). The detection signal thus outputted is applied to the system controller 11.

The system controller 11 comprising a microcomputer performs various control operations according to instructions from an operating section 13, and controls a motor drive circuit 14 to carry out the drive and stop controls of th spindle motor 2.

Now, the control procedure carried out by the processor in the system controller when the spindle motor 2 is at rest will be described with reference to a flow chart shown in Fig. 2.

When, from the output data of the data extracting circuit 10, it is detected that the specified last piece of music has been performed in a program music performance mode or when the last piece of music has been performed in an ordinary music performance mode, or when the operating section 13 issues a performance stop instruction, the processor controls the motor drive circuit 14 so that a negative drive voltage is applied to the spindle motor 2 to apply a reverse torque braking force to the motor 2 (Step S1), and then the processor

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starts a timer incorporated therein (Step S2). The processor monitors the input from the number of rotations detecting circuit 12 to determine whether or not the number of rotations of the spindle motor 2 is decreased to about one-third (1/3) of the predetermined value (rpm) (Step S3). When it is detected from the detection signal of the number of rotations detecting circuit 12 that the number of rotations of the spindle motor 2 has been decreased to about one-third of the predetermined value, a time t (= T/2) is calculated from the time interval which elapses from the time instant that the reverse torque braking force is applied to the spindle motor until the detection signal is produced; that is, the count value T of the timer mentioned above (Step S4). It is necessary to adjust the time t by adding a predetermined value a thereto or subtracting it therefrom, as the case may be. Then, the timer is started again (Step S5), and the lapse of the time t thus calculated is monitored (Step S6). Upon detection of the lapse of the time t, the processor controls the motor drive circuit 14 to suspend the application of the reverse torque braking force to the spindle motor 2 (Step S7).

As was described above, in the invention, in stopping the spindle motor 2 by application of the reverse torque braking force thereto, it is detected when the number of rotations of the spindle motor is decreased, for instance, to one-third of the predetermined value, the time interval T which elapsed from the time instant that the reverse torque braking force is applied to the spindle torque until the detection signal is outputted is measured to calculate the time t (= T/2), and the application of the reverse torque braking force is allowed to last as long as the time t from the production of the detection output by the number of rotations detecting circuit. Therefore, even in the playing of a CLV disc, the spindle motor 2 can be quickly and positively stopped independently of the number of rotations of the spindle motor at the application of the reverse torque braking force. This is based on the fact that, when a reverse torque braking force acts on an object rotating with a moment of inertia, its number of rotations (rpm) is proportional to the lapse of time as shown in Fig. 3.

In the above-described embodiment, the time interval T required for the number of rotations of the spindle motor 2 to decrease to one-third of the specified value is measured, and the time t are calculated from the value T (t = T/2). However, it should be noted that the invention is not limited thereto or thereby. That is, generally stated, a time interval T required for the number of rotations of the spindle motor 2 to decrease to 1/n (where n is not limited to natural number only) of the specified value is measured, and a period of time t is calculated from the time interval T thus measured according to the equation t = T/(n-1), and the application of the reverse torque braking force is allowed to last as long as the period of time t from the production of the above-described detection signal.

In the above-described embodiment, the number of rotations detecting circuit 12 has its own block in Fig. 1, and the frame synchronization signal's pulse width is detected by hardware. However, it goes without saying that the controller 11 may have the function of the number of rotations detecting circuit 12, to detect the frame synchronization signal's pulse width by software. In this case, the processor operates is as shown in Fig. 4; that is, instead of Step 3 shown in Fig. 3, Steps S3a and S3b are carried out. More specifically, after the start of the timer, the processor receives a frame synchronization signal from the frame synchronization detecting circuit 6 (Step S3a), to determined whether or not the frame synchronization signal's pulse width is 64T or more (Step S3b). As a result, it can be determined whether or not the speed of the spindle motor 2 has been decreased to one-third or less of the specified value.

As was described above, with the spindle motor stop control device of the invention, in stopping the spindle motor by application of the reverse torque braking force thereto, it is detected when the number of rotations of the spindle motor has been decreased to 1/n of the specified value, and the time interval T which elapses from the time instant that the reverse torque braking force is applied to the spindle motor until the detection output is produced is detected to calculate the period of time t which is the function of the time interval T, so that the application of the reverse torque braking force is allowed to last for the period of time t from the time of production of the detection signal. Therefore, according to the invention, even in the playing of a CLV disc, the spindle motor can be quickly and positively stopped with the simple circuit described above, without using an expensive frequency generator.

Claims

1. A spindle motor stop control device for applying a reverse torque braking force to a spindle motor (2) for rotating a data record disc (1), the device comprising

means (12) for detecting the speed of rotation of the spiundle motor and outputting a detection signal when the speed has decreased to 1/n of a predetermined value in response to a reverse torque braking force;

means (11) for measuring the time interval T which has elapsed from the time instant that the reverse

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torque braking force is applied to the spindle motor until the detection signal is outputted;
arithmetic means (11) for calculating a period of time t which is a function of the time interval T; and,
means (11) for continuing the application of the reverse torque braking force for the period of time t from the production of the detection signal.

2. A device according to claim 1, wherein the arithmetic means (11) includes means for calculating the time period t from the function $t = T/(n-1)$.

3. A device according to claim 1 or claim 2, wherein the speed detection means (12) comprises a frame synchronisation signal detector (6) responsive to a frame synchronisation signal reproduced from the data record disc rotated by the spindle motor, and an rpm detector (12) responsive to the frame synchronisation signal detector.

4. A device according to claim 1 or claim 2,wherein the speed detection means (12) comprises a frame synchronisation signal detector (6) responsive to a frame synchronisation signal reproduced from the data record disc rotated by the spindle motor, and means for detecting when the duration of the detected frame synchronisation signal is at least a predetermind multiple of the duration of the frame synchronisation signal when the spindle speed is at the predetermined value.

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Neu eingereicht / Newly filed
Nouvellement déposé

FIG. 1

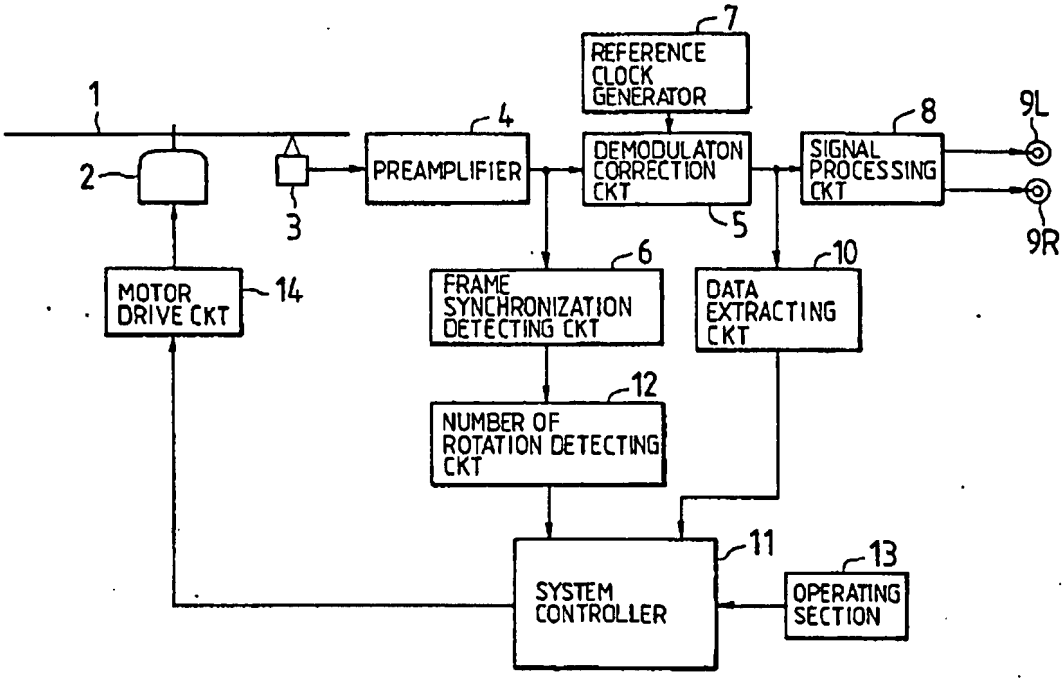

FIG. 3

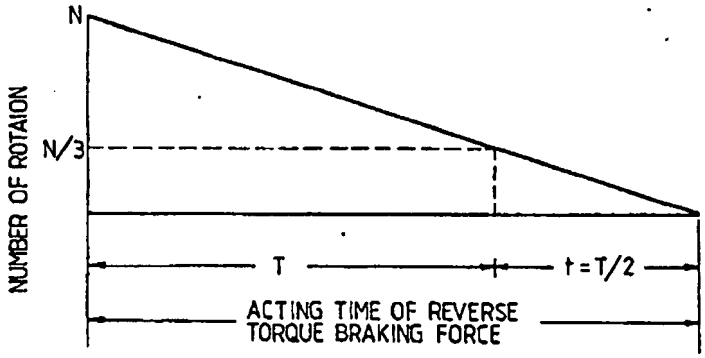

FIG. 2

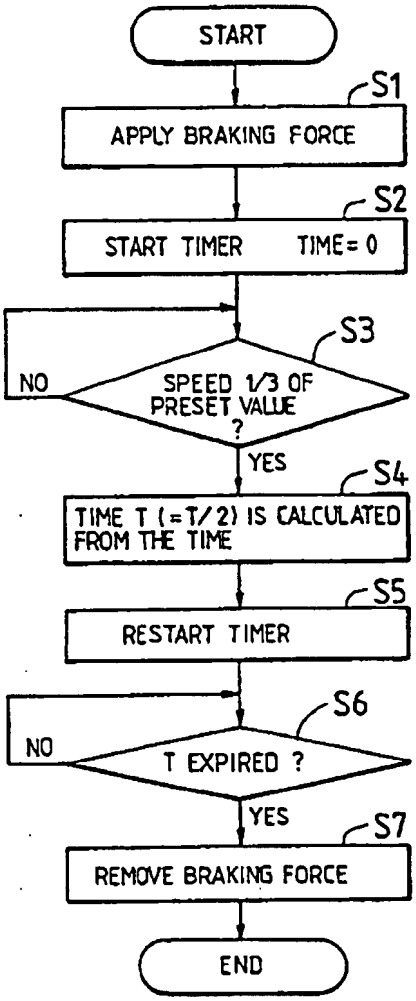
START
S1
APPLY BRAKING FORCE
S2
START TIMER TIME= 0
S3
NO
SPEED 1/3 OF PRESET VALUE ?
YES
S4
TIME T (=T/2) IS CALCULATED FROM THE TIME
S5
RESTART TIMER
S6
NO
T EXPIRED ?
YES
S7
REMOVE BRAKING FORCE
END

FIG. 4

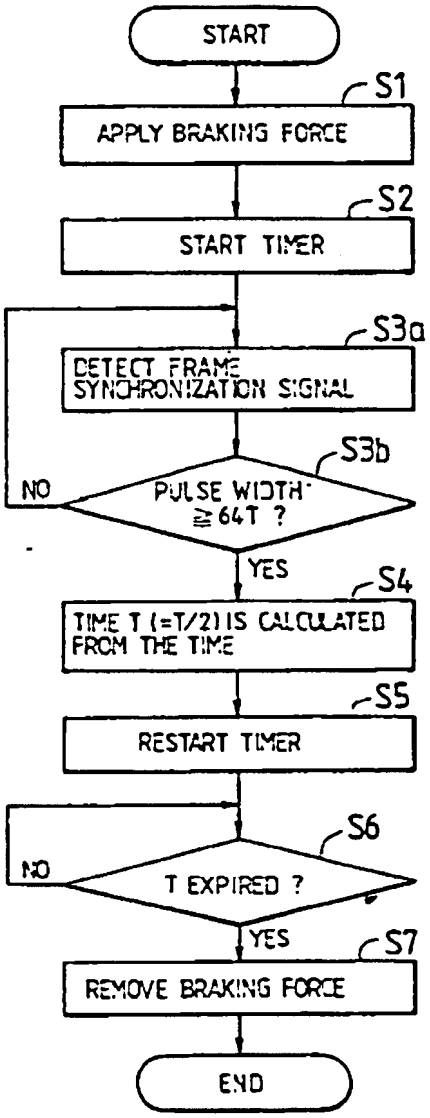
START
S1
APPLY BRAKING FORCE
S2
START TIMER
S3a
DETECT FRAME SYNCHRONIZATION SIGNAL
S3b
NO
PULSE WIDTH ≧64T ?
YES
S4
TIME T (=T/2) IS CALCULATED FROM THE TIME
S5
RESTART TIMER
S6
NO
T EXPIRED ?
YES
S7
REMOVE BRAKING FORCE
END

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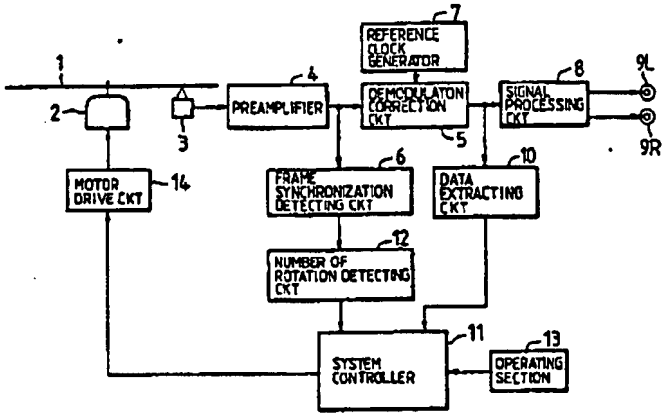
FIG. 1



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European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 31 2025

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	PATENT ABSTRACTS OF JAPAN vol. 11, no. 209 (E-521)(2656), 7 July 1987; & JP - A - 62 031382 (MITSUBISHI) 10-02-1987 ---	1	H 02 P 3/00 G 11 B 19/20
Y	US-A-3 668 494 (G.J. AGIN) * column 3, line 38 - column 4, line 24; figures 4-6 * ---	1	
A	PATENT ABSTRACTS OF JAPAN vol. 8, no. 142 (E-254)(1579), 3 July 1984; & JP - A - 59 050785 (TOKYO SHIBAURA) 23-03-1984 -----	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 02 P 3/00
G 11 B 19/00
H 02 P 6/00
H 02 P 8/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	08-02-1990	LEOUFFRE M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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E : earlier patent document, but published on, or after the filing date
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